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Modelling the interaction between subducted slabs and thermo-chemical piles

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Based on the reconstructed eruption locations of volcanic products (Large Igneous Provinces and kimberlites) it has recently been proposed that most plumes get generated at the steep edges of the large low shear-velocity provinces (LLSVPs) and that these edges have not discernibly moved over the past few hundred Myr. Following this idea, it is of specific importance to investigate the influences on the movement of these edges, which would determine the surface plume positions. Independent of this argumentation, the position and shape of the LLSVPs are a main factor in mantle convection and should be reproduced by models which show an earth-like convection pattern. In current models this is done in a rather qualitative way, with a focus either only on position or only on shape.

In our 3D geodynamic numerical models of the global mantle we combine several of the improvements to mantle convection models made during the last few years: A complex plate reconstruction is used as a kinematic boundary condition. A self-consistent thermodynamic material model for basalt, harzburgite and peridotite is used to derive a temperature- and/or pressure-dependent database for parameters like density, thermal expansivity and specific heat. Furthermore, we use a viscosity profile derived from surface observations and mineral physics constraints. We use the model to clarify the influence of surface motions on processes at the CMB and vice versa.

The results of our models show not only that it is possible to generate LLSVPs at the actual position and with a similar shape compared to what is observed through seismic tomography, but even to recreate plumes at positions that match many of today's hot spots. A thorough investigation on the statistical significance of this observation will be presented. We will also show the influence of boundary and initial conditions. Furthermore, we will discuss the possibility to create a model matching seismic tomography and plume positions without a chemical boundary layer at the core-mantle boundary, and the difference in stability of the LLSVPs between a harzburgitic and a peridotitic ambient mantle.